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FINAL REPORT

NATIONAL LEAD INDUSTRIES
PEDRICKTOWN, NEW JERSEY

ECOLOGICAL RISK ASSESSMENT

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INTRODUCTION

The National Lead (NL) Industries site is an abandoned secondary lead smelting facility located in Pedricktown, New Jersey, approximately 1.5 miles east of the Delaware River. Lead batteries and other lead materials were handled at this facility, which operated from 1972 to 1984. While several site-related contaminants have been identified, lead has been targeted as the contaminant of primary concern.

A field investigation was conducted to collect data to support an ecological risk assessment for the NL Industries site. The objectives of the study were to collect site-specific data on uptake of lead by biota in the contaminated area. The investigation focused on two streams running along the east and west side of the former lead smelting facility, and forested wetland areas associated with these drainages. Although the area occupied by NL Industries is 44 acres, preliminary X-ray fluorescence (XRF) surveys indicated that the contaminated area associated with the above drainage was approximately 200 acres.

The forested area east of the NL facility is dominated by sweetgum (*Liquidamber styraciflua*) and black cherry (*Prunus serotina*). Occasional gaps in the canopy allow a scattered groundcover of arrowwood viburnum (*Viburnum dentatum*), wild blackberry (*Rubus sp.*) and wild currant (*Ribes sp.*). The forested area west of the facility is dominated by red maple (*Acer rubrum*), with some arrowwood in the understory. The area immediately adjacent to the west side stream is open, and dominant plant species are arrow-leaved tearthumb (*Polygonum sagittatum*) and elderberry (*Sambucus canadensis*).

Selection of receptor species, for the risk calculations, was based on probable species at the NL Industries site, the position of these species within the food chain, contaminant fate and transport within the food chain, the availability of toxicity literature on which risk calculations could be based, and potential sensitivity of the receptor to lead. Receptor species were chosen to represent higher levels of the terrestrial and avian food web. Species identified as receptors for this risk assessment were robin (*Turdus migratorius*), woodcock (*Philohela minor*), great blue heron (*Ardea herodias*), red-tailed hawk (*Buteo jamaicensis*), long-eared owl (*Asio otus*), red fox (*Vulpes vulpes*), and mink (*Mustela vison*).

To evaluate the potential risk of consumption of forage from the contaminated area, forage species utilized by the above receptor species were sampled to determine tissue lead concentrations. Soils, sediments, frogs and small mammals were collected on-site and analyzed for lead. Earthworms were exposed to site soils in *in situ* bioaccumulation chambers, allowed to depurate, and analyzed.

Sampling areas were selected such that accumulation of lead by forage species exposed to a gradient of lead levels in environmental media could be evaluated. Soil lead levels in the earthworm chambers ranged from 120 to 6900 mg/kg. For this risk assessment, the uptake of lead by earthworms was evaluated for the following ranges of soil contamination: < 500 mg/kg; 500 to 1000 mg/kg; and > 1000 mg/kg. Sufficiently large sampling locations for small mammals and frogs with soil/sediment lead less than 500 mg/kg could not be located within the immediate area of the site. Uptake of lead by these species was evaluated for the following ranges of soil/sediment contamination: < 1000 mg/kg; 1000 to 2000 mg/kg; and > 2000 mg/kg. Surface water results were broken down into low, medium and high concentration, and paired with appropriate soil or sediment data classes.

ASSUMPTIONS

This risk assessment focuses on exposure to lead through ingestion. Potential risk is based upon administered dose, rather than accumulated or available lead from the forage. One hundred percent (100%) adsorption efficiency is also assumed within the present model. Site forage species were sampled to generate more realistic ingested dose data for the model. Additionally, collected organisms were either depurated or stomach and lower digestive tract material was removed prior to analyses. The incidental ingestion of soil or sediment by receptors is considered as a separate factor within the model.

A literature search was conducted to determine chronic toxicity of lead when ingested by the receptor species. When values for chronic toxicity were not available, LD_{50} values were used. For purposes of this risk assessment, a factor of 10 was used to convert the reported LD_{50} to a Lowest Observed Adverse Effect Level (LOAEL). When several toxicity values were found, the more conservative value was used in the risk calculations.

In some cases, contaminant doses were reported as ppm in diet. These were converted to daily intake in mg/kg bodyweight/day using the formula:

Daily intake = Contaminant dose (mg/kg) X Ingestion rate (kg/day) X 1/bodyweight (kg)

Average ingestion rate and bodyweight for species were obtained from the literature.

Several species selected as receptors have home ranges larger than the contaminated area at the NL Industries site. When several home range sizes were reported for a species, values reported for animals in New Jersey were used. If no New Jersey home range values were available, the most conservative value was used in the

risk calculations. An area use factor was calculated to weigh the estimated dose by the proportion of time the animal would use the contaminated resource relative to its home range. This is a simplifying assumption which assumes time and space allocations are proportional, and does not account for differential habitat usage. In addition, loss of contaminant from the body during the time the animal is not utilizing the contaminated area is not addressed. Home range data was not available for several bird species, so territory or feeding area sizes were used. All avian receptor species used in this risk assessment are potential year-round residents in southern New Jersey (Fables 1955). The area use factor is defined as one if the study area is greater than the home range of a species. If the study area is less than the home range, a ratio of home range size to the size of the study area was used.

EXPOSURE PROFILE

The purpose of an exposure profile is to determine concentrations of contaminants to which receptors utilizing the contaminated area at the NL site are exposed. Exposure pathways considered in this risk assessment for the following species are:

Robin
- Ingestion of earthworms
- Ingestion of soils

Woodcock
- Ingestion of earthworms
- Ingestion of soils

Great blue heron
- Ingestion of aquatic biota (frogs)
- Ingestion of sediment
- Ingestion of water

Red-tailed hawk
- Ingestion of small mammals

Long-eared owl
- Ingestion of small mammals

Red fox
- Ingestion of small mammals
- Ingestion of soil

Mink
- Ingestion of small mammals
- Ingestion of aquatic biota (frogs)
- Ingestion of soil
- Ingestion of water

These exposure pathways and receptor species were selected to be representative of actual exposure pathways which occur at the site. While other exposure pathways are possible for some of the receptors, only the pathways presented were considered for this risk assessment.

For all of the receptors listed above, daily intake of lead via each applicable pathway will be calculated using the following equations:

$$\text{Daily intake}_{forage} = \text{Lead in forage} \times \text{Percent of diet} \times \text{Area use factor} \times \text{Ingestion rate} \times 1/\text{bodyweight}$$

$$\text{Daily intake}_{soil} = \text{Lead in soil/sediment} \times \text{Area use factor} \times \text{Ingestion rate} \times 1/\text{bodyweight}$$

$$\text{Daily intake}_{water} = \text{Lead in water} \times \text{Area use factor} \times \text{Ingestion rate} \times 1/\text{bodyweight}$$

Lead levels measured in forage species (earthworms, frogs and small mammals) collected on-site are presented in Tables 1, 2, and 3. Lead levels in soils from the earthworm bioaccumulation chambers were measured using atomic absorption analysis (Table 1). Lead levels were measured in sediments and soils at locations where frogs and small mammals were collected using XRF (Tables 2 and 4, respectively).

Because soil and sediment samples were oven dried prior to XRF analysis, lead levels were reported in dry weight and needed to be converted to wet weight to compare lead levels in media to lead levels in biota. Percent moisture values were only obtained for soil and sediment samples submitted for AA (soil from earthworm chambers) or TOC/grain size (sediments) analysis. Mean percent moisture values from these soil and sediment samples were used to convert XRF measurements from dry weight to wet weight.

Surface water samples were not collected during this field investigation, so surface water data from the Remedial Investigation were used for site-specific lead levels in water (Table 5; O'Brien and Gere, Inc. 1990).

Assumptions and life history information used to estimate dietary exposure of indicator species via forage ingestion are summarized below. Life history information tables are also presented in Appendix A.

Soil ingestion rates have only been reported for a few wildlife species. For purposes of this risk assessment, a soil ingestion rate of an ecologically or taxonomically similar species was used for species which do not have a reported soil ingestion rate.

Where reasonable, the following allometric equations derived by Calder and Braun (1983) was used to estimate water ingestion rates:

Mammals: Water ingestion rate (L/day) = $0.099\ Wt^{0.90}$

Birds: Water ingestion rate (L/day) = $0.059\ Wt^{0.67}$

Weight (Wt) is the average body weight of a species in kilograms.

Two exposure scenarios were calculated, one which estimated exposure based on an average lead dose, and the second which estimated exposure based on a more conservative dose. Scenario 1 was calculated using mean lead levels in forage or prey species collected on-site. Scenario 2 was calculated using mean lead levels plus one standard deviation of the mean.

Robin

An average adult robin weighs 78 g and can consume 8.7 g of food per day (Levey and Karasov 1989). Invertebrates comprise 43% of the diet, with the other 57% being fruits and vegetation (Palmer and Fowler 1975). A soil ingestion rate of 0.8 g/day (9.1% of dietary ingestion rate) was estimated using soil ingestion data reported for the woodcock (Beyer et al. 1991). The territory size reported for this species is 1.04 acres (Pitts 1984), therefore an area use factor of one was used for the robin.

Woodcock

An adult woodcock weighs 165 g and consumes 83 g of food per day, with the majority of its diet consisting of earthworms (Sheldon 1967). A woodcock ingests 7.5 g of soil per day (Beyer et al., 1991). Home range size of a woodcock is 45 acres (Wilson 1982), so a woodcock could obtain 100% of its diet from the contaminated area at the NL Industries site.

Great Blue Heron

An average adult heron weighs 3.0 kg, and ingests 0.6 kg of food per day (Newell et al., 1987). The majority of the diet consists of aquatic organisms (Erwin and Spendelow 1991). A soil ingestion rate of 54 g per day (9% of the dietary ingestion rate) was estimated using soil ingestion rates reported for shore birds and Canada geese (Beyer et al., 1991). Erwin and Spendelow (1991) estimate that the extent of wetland habitat needed as a feeding area by herons has a 10 km radius (approximately 70,000 acres). Herons ingest 0.12 L of water per day (Calder and Braun 1983).

Long-Eared Owl

The average bodyweight of an adult owl is 222 g (Johnsgard 1987). Owls consume 38 g of food per day (Johnson 1978), with the diet consisting predominantly of small mammals (Johnsgard 1987). Johnsgard (1987) reported a territory size of 136 acres, so the area use factor for this species is one.

Red-Tailed Hawk

An adult red-tailed hawk weighs 1.3 kg and ingests 136 g of food per day (Kirkwood 1980), with small mammals comprising a significant portion of the diet (Johnsgard 1990). A home range size of 320 acres has been reported for a red-tailed hawk (Fitch et al., 1988); an area use factor of 63% was, therefore used.

Red Fox

An average adult fox weighs 5 kg and can consume 0.32 kg of food per day (Samuel and Nelson 1982). Small mammals are the main prey item consumed by foxes (Hamilton 1935). Home range sizes ranging from 57.5 to 162 ha have been reported for red fox (Samuel and Nelson 1982). A conservative home range size of 57.5 ha (142 acres) will be used for this risk assessment, therefore the area use factor for red fox is one. The soil ingestion rate that was used for fox is 9 g/day (Beyer et al., 1991).

Mink

Mink were included in this risk assessment as they occur in the state of New Jersey and inhabit wetlands. An average mink weighs 1 kg and can consume 0.15 kg of food per day (Bleavins et al., 1980). Mink will consume both aquatic and terrestrial prey, and utilize whatever is readily available (Linscombe et al., 1982). For purposes of this risk assessment, it was assumed that small mammals comprised 50% of the diet, while frogs comprised the other 50% of the diet. Home range size for adult males averages 2,630 m in stream length, while average home range size for an adult female is 1,850 m of stream length (Linscombe et al., 1982). The combined length of the East (approximately 1520 m) and West stream (approximately 850 m) is 2370 m, so a female mink could utilize contaminated stream habitat 100% of the time, while a male could utilize the contaminated area 90% of the time.

Calculated daily intake levels of lead for all of the above species are presented in Table 6. Spreadsheets with daily intake calculations are presented in Appendix B.

RISK CHARACTERIZATION

To estimate risk to wildlife utilizing the contaminated area at this site, implications of the estimated exposure concentrations need to be determined. The Hazard Quotient method (Barnthouse et al., 1986, U.S. EPA 1989) was used to compare exposure concentration to ecological endpoints (e.g., reproduction or growth effects). The comparisons are expressed as ratios of potential intake values to documented effect values, or:

$$\text{Hazard Quotient} = \frac{\text{Total Daily Intake}}{\text{Level shown to cause ecological effect (Low Observed Adverse Effect Level)}}$$

A hazard quotient greater than one indicates that, given the assumptions of the exposure scenario, the exposure to the contaminant could cause deleterious health effects. A hazard quotient less than one does not indicate a lack of risk, but should be interpreted based on the severity of the effect reported, and the magnitude of the calculated quotient. This approach is different from the hazard quotient method used in human health risk assessment (U.S. EPA 1989), where a No Observed Adverse Effect Level (NOAEL) is used to calculate the hazard quotient. The quotient calculated for this ecological risk assessment uses the LOAEL as the divisor.

A literature search was conducted to find dietary doses of lead reported to cause toxic effects in birds and mammals. LOAELS obtained from the literature (Table 7) and the site specific daily intake levels calculated (Table 6) were used to calculate hazard quotients for the different species. Calculated hazard quotients are presented in Table 8.

Literature values for toxicity of lead to robins and woodcock were not available. Generally, dietary levels of lead below 100 ppm (approximately 20 to 35 mg per kg bodyweight per day, depending upon ingestion rate to body weight ratio) cause few significant effects in birds (Scheuhammer 1987). Daily administration of 28 mg organic lead per kg bodyweight to European starlings resulted in 100% mortality after six days. Exposure to 3 mg organic lead per kg bodyweight per day (mg/kgBW/day) resulted in a reduction in muscle condition and altered feeding activity (Osborn et al., 1983). Grue et al., (1986) studied reproductive success in European starlings nesting within the verge of a heavily travelled highway. Lead measured in ingesta ranged from 84 to 94 mg/kg dry weight (4.1 mg/kgBW/day). Although no difference in reproductive parameters was noted between the control and the highway birds, a significant reduction in hematocrit, red blood cell ALAD activity and brain weight of nestlings from the highway colony was observed.

Using a LOAEL of 4.1 mg per kg bodyweight per day in the hazard quotient calculations, robin or woodcock consuming earthworms from any area on this site would be at risk of deleterious effects from the lead levels in their diet, having hazard quotients of 1.23 to 5.00 and 10.19 to 28.35, for each indicator species respectively.

An LOAEL could not be obtained for the great blue heron. The closest species that literature values could be obtained for was the mallard duck. Mallard ducks given a diet containing 100 mg/kg metallic Pb (20 mg per kg bodyweight per day) for a period of 42 days had a significant elevation of lead levels in bone and eggs compared to control animals (Haegele et al., 1974).

Hazard quotients calculated using this LOAEL (<0.01) do not suggest that great blue herons would be at risk from lead exposure from a diet containing frogs, sediment and water from the contaminated area. Even when making the unlikely assumption that a nesting great blue heron could obtain its entire diet from the contaminated area for a period of a half a year, the hazard quotient is still less than or equal to one (0.19 to 1.00).

Red-tailed hawks which ingested 3 mg/kgBW/day for a 30 week period exhibited clinical symptoms of lead poisoning (Reiser and Temple 1981). A literature value for toxicity of lead to owls could not be located, so the LOAEL cited for hawks was used to evaluate risk of lead ingestion by owls. Hazard quotients calculated using this LOAEL (0.04 to 0.18) do not suggest red-tailed hawks or long-eared owls would be at risk from lead exposure from a diet containing small mammals from the contaminated area.

Literature values are not available for effects of lead on foxes, but several studies have been done with dogs. A dietary dose greater than 0.32 mg/kgBW/day caused chronic toxic effects in dogs (Demayo et al., 1982), consumption of 2.5 mg/kgBW/day caused an inhibition of ALAD (Azar, 1972), and consumption of 3 mg/kgBW/day resulted in anorexia and convulsions (Clark 1979). A review of the experimental design of DeMayo et al. (1982) indicated that the LOAEL from this study was not appropriate for use in this risk assessment and the next conservative LOAEL was selected. The hazard quotient calculated using a LOAEL of 2.5 mg/kgBW/day indicates foxes consuming small mammals in Area I and Area IA using Scenario 2 and using either Scenario 1 or 2 in Area III area are at risk of deleterious effects from lead levels in their diet (hazard quotient ranging from 0.48 to 1.82).

Lead poisoning has been documented in captive mink housed in sheds painted with lead based paint (Purdy 1962). However, no studies have been conducted to evaluate effects of dietary exposure to lead on mink. Mason and MacDonald (1986) evaluated distribution of otter (*Lutra lutra*) relative to dietary intake of lead and cadmium. Daily lead intake was estimated based on measured fecal lead

levels, known ingestion rate for otter, and gastrointestinal lead absorption rates for mammals. Estimated lead intake correlated well with levels measured in major fish prey species. No apparent impact on population levels was found when lead intake was less than 0.15 mg per kg bodyweight per day. Otter populations were reduced in areas where estimated lead intake exceeded 2 mg per kg bodyweight per day. Using the latter value as an LOAEL for mink, mink would be at risk from consumption of prey from any area at this site (hazard quotients ranging from 1.32 to 3.28 for males and 1.46 to 3.64 for females).

SOURCES OF UNCERTAINTY

There are uncertainty factors inherent in the risk assessment process which need to be considered when interpreting results. Use of values cited in the literature is an important source of uncertainty. Literature values for life history information (e.g., home range, ingestion rate) used in the exposure profile may not be representative of values for species in the New Jersey area. Species respond differently to exposure to toxins, and literature values were not available for all receptor species. Although reported LOAELs used in the quotient calculations are for the most closely related species available, responses to lead by species evaluated in this risk assessment may be different than in species for which data is available. Values obtained from the literature may over- or underestimate actual values for species addressed in this risk assessment.

Another source of uncertainty arises because toxicity values reported in the literature are often derived in single species, single contaminant laboratory studies. Prediction of ecosystem effects from laboratory studies is difficult, as environmental factors and interactions between contaminants can influence toxin effects.

Uncertainty was reduced in this study by collection and analysis of prey species on-site, which allowed quantification of movement of lead from soil/sediment into lower trophic level organisms.

An additional source of uncertainty is the form of lead used within the dosing studies. It is known that various chemical forms of lead have significantly different toxicities, particularly organo-leads. It is currently not possible to incorporate alteration of toxicity due to chemical form or availability within the exposure model. Also the availability and form undoubtedly varies within the NL site, potentially including metallic lead, casing bound lead, various inorganic forms, as well as other forms.

CONCLUSIONS

The assumptions utilized in this ecological risk assessment are conservative but reasonable. Site-specific data was used to characterize exposure of biota to site-related contaminants. The daily intake calculations represent realistic exposure levels for biota utilizing the site, and are indicative of potential for risk to the environment.

Lead does not pose a risk to great blue heron or red-tailed hawk obtaining food from the contaminated area. The large home range size of these animals compared to the contaminated area suggests that exposure to lead is limited by the amount of time the birds would be expected to utilize this portion of their home range. Lead does not appear to pose a risk to long-eared owl, even though this species could obtain 100% of its diet from the contaminated area.

Lead levels found on-site pose a risk to robin and woodcock feeding on earthworms. Hazard quotient calculations using daily intake estimates from either Scenario 1 or 2 indicate lead poses a risk to red fox and mink feeding on prey captured in any area.

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TABLE 1. Lead concentrations measured in soil and earthworms from *in situ* bioaccumulation chambers. Earthworms were exposed to site soils for 30 days.
National Lead Industries Site
Pedricktown, New Jersey

	Lead in Soil (mg/kg dry weight)		Mean Percent Moisture	Lead in Soil (mg/kg wet weight)		Lead in Earthworms (mg/kg wet weight)	
	Mean	SD		Scenario 1[a]	Scenario 2[b]	Mean	SD
Soil lead < 500 mg/kg	246.0	129.3	24.9	184.7	281.9	66.3	44.2
Soil lead 500 - 1000 mg/kg	786.7	58.6	29.7	553.1	594.2	80.0	48.1
Soil lead > 1000 mg/kg	3150.0	2290.5	48.9	1609.7	2780.1	85.7	42.7

[a] Scenario 1 calculated using mean lead levels in sediment
[b] Scenario 2 calculated using mean lead levels plus one standard deviation

TABLE 2. Lead concentration measured in sediment and green frogs (*Rana clamitans*) collected from the East and West stream drainages. Lead in sediments was analyzed using XRF.
National Lead Industries Site
Pedricktown, New Jersey

	Lead in Sediment (mg/kg dry weight)		Percent Moisture[a]	Lead in Sediment (mg/kg wet weight)		Lead in Frogs (mg/kg wet weight)	
	Mean	SD		Scenario 1[b]	Scenario 2[c]	Mean	SD
Sediment lead < 1000 mg/kg	862	201	57.0	371	457	5.02	3.96
Sediment lead 1000 - 2000 mg/kg	1024	285	57.0	440	563	5.00[d]	5.09
Sediment lead > 2000 mg/kg	4568[d]	62	57.0	1963	1991	13.32	6.90

[a] Mean percent moisture measured in 5 sediment samples collected for TOC and grain size analysis.
[b] Scenario 1 calculated using mean lead levels in sediment
[c] Scenario 2 calculated using mean lead levels plus one standard deviation
[d] Based on a sample size of n = 2.

TABLE 3. Mean whole body lead concentration in white-footed mice (*Peromyscus leucopus*) captured on-site.
National Lead Industries site.
Pedricktown, New Jersey

	Number of animals	Mean lead concentration (mg/kg wet weight)	Standard deviation	Range of values
Area I and IA	11	1.60	1.07	0.20 - 3.30
Area II	15	3.10	3.02	0.87 - 13.0
Area III	12	4.77	3.49	0.89 - 13.0

TABLE 4. Lead concentration in surface soils in small mammal trapping grids as measured by XRF.
National Lead Industries Site
Pedricktown, New Jersey

	Lead in Soils (mg/kg dry weight)		Percent Moisture[a]	Lead in Soils (mg/kg wet weight)	
	Mean	SD		Scenario 1[b]	Scenario 2[c]
Grid I	1963	1062	40.04	1177	1814
Grid IA	1515	771	40.04	908	1371
Area I (Grids I and IA)	1705	914	40.04	1022	1570
Area II	917	801	40.04	550	1030
Area III	2277	1439	40.04	1365	2228

[a] Percent moisture is mean percent moisture measured in soils from earthworm chambers, n = 20.
[b] Scenario 1 calculated using mean lead levels in sediment
[c] Scenario 2 calculated using mean lead levels plus one standard deviation

TABLE 5. Lead levels measured in surface water samples.
Results are from samples collected during the Remedial Investigation in 1988 and 1989.
National Lead Industries Site
Pedricktown, New Jersey

	Sample size	Mean Lead (mg/kg)	Standard Deviation (mg/kg)	Range of values (mg/kg)
Low (< 0.1 mg/kg)	13	0.049	0.033	0.010 - 0.098
Medium (0.1 - 1.0 mg/kg)	10	0.257	0.129	0.100 - 0.418
High (> 1.0 mg/kg)	7	1.847	0.696	1.06 - 3.00

TABLE 6. Daily intake of lead by biota utilizing forage from the NL Industries site
Scenario 1 calculated using mean lead levels detected on-site; Scenario 2 calculated using mean lead plus one standard deviation

RECEPTOR SPECIES	LEAD IN MEDIA (mg/kg)	SCENARIO 1 DAILY INTAKE (mg/kg bodyweight/day)				SCENARIO 2 DAILY INTAKE (mg/kg bodyweight/day)			
		Forage	Soil/ Sediment	Water	Total	Forage	Soil/ Sediment	Water	Total
ROBIN	Soil, < 500	3.16	1.89	nc	5.05	5.27	2.88	nc	8.15
	Soil, 500-1000	3.82	5.64	nc	9.46	6.11	6.06	nc	12.17
	Soil, > 1000	4.09	16.42	nc	20.51	6.13	28.37	nc	34.49
WOODCOCK	Soil, < 500	33.35	8.41	nc	41.76	55.58	12.82	nc	68.40
	Soil, 500-1000	40.24	25.41	nc	65.38	64.44	27.00	nc	91.44
	Soil, > 1000	43.11	73.14	nc	116.25	64.59	126.36	nc	190.95
GREAT BLUE HERON AUF = 0.3%	Sediment, < 1000	0.00	0.02	0.00	0.02	0.01	0.02	0.00	0.03
	Sediment, 1000-2000	0.00	0.02	0.00	0.02	0.01	0.03	0.00	0.04
	Sediment, > 2000	0.01	0.11	0.00	0.12	0.01	0.11	0.00	0.12

nc indicates exposure pathway not considered for this species
AUF = Area use factor

TABLE 6 (continued). Daily intake of lead by biota utilizing forage from the NL Industries site
Scenario 1 calculated using mean lead levels measured on-site; Scenario 2 calculated using mean lead plus one standard deviation

RECEPTOR SPECIES	LEAD IN MEDIA (mg/kg)	SCENARIO 1 DAILY INTAKE (mg/kg bodyweight/day)				SCENARIO 2 DAILY INTAKE (mg/kg bodyweight/day)			
		Forage	Soil	Water	Total	Forage	Soil	Water	Total
GREAT BLUE HERON AUF = 50%	Sediment, < 1000	0.50	3.34	0.00	3.84	0.90	4.11	0.00	5.01
	Sediment, 1000-2000	0.50	3.96	0.01	4.47	1.01	5.07	0.01	6.08
	Sediment, > 2000	1.33	17.67	0.04	19.04	2.02	17.92	0.05	19.99
RED-TAILED HAWK	Area II < 1000	0.20	nc	nc	0.20	0.40	nc	nc	0.40
	Area I & IA 1000-2000	0.11	nc	nc	0.11	0.18	nc	nc	0.18
	Area III > 2000	0.31	nc	nc	0.31	0.54	nc	nc	0.54
LONG-EARED OWL	Area II < 1000	0.53	nc	nc	0.53	1.05	nc	nc	1.05
	Area I & IA 1000-2000	0.27	nc	nc	0.27	0.46	nc	nc	0.46
	Area III > 2000	0.82	nc	nc	0.82	1.41	nc	nc	1.41

nc indicates exposure pathway not considered for this species
AUF = Area use factor

TABLE 6 (continued). Daily intake of lead by biota utilizing forage from the NL Industries site
Scenario 1 calculated using mean lead levels detected on-site; Scenario 2 calculated using mean lead plus one standard deviation

	LEAD IN MEDIA (mg/kg)	SCENARIO 1 DAILY INTAKE (mg/kg bodyweight/day)				SCENARIO 2 DAILY INTAKE (mg/kg bodyweight/day)			
		Forage	Soil/ Sediment	Water	Total	Forage	Soil/ Sediment	Water	Total
RED FOX	Area II < 1000	0.20	0.99	nc	1.19	0.39	1.85	nc	2.25
	Area I & IA 1000-2000	0.10	1.84	nc	1.94	0.17	2.83	nc	3.00
	Area III > 2000	0.31	2.46	nc	2.76	0.53	4.01	nc	4.54
MINK, MALE	Area II < 1000	0.55	2.08	0.02	2.63	1.02	3.89	0.03	4.95
	Area I & IA 1000-2000	0.45	3.86	0.00	4.31	0.86	5.93	0.01	6.80
	Area III > 2000	1.22	5.16	0.17	6.55	1.92	8.42	0.23	10.57
MINK, FEMALE	Area II < 1000	0.61	2.31	0.03	2.94	1.13	4.33	0.04	5.50
	Area I & IA 1000-2000	0.50	4.29	0.00	4.82	0.96	6.59	0.01	7.56
	Area III > 2000	1.36	5.73	0.18	7.27	2.14	9.36	0.25	11.75

nc indicates exposure pathway not considered for this species

TABLE 7. Summary of lethal and sublethal effects of ingested lead.

SPECIES	EXPOSURE PERIOD	DIETARY EXPOSURE (mg/kg/day)	EFFECT	REFERENCE
Red-tailed Hawk[a]	30 Weeks	3	Clinical symptoms of lead poisoning	(Reiser and Temple 1981)
Otter[b]	Lifetime	0.15	No apparent population level effects	(Mason and MacDonald 1986)
Otter[b]	Lifetime	2.00	Reduced population	(Mason and MacDonald 1986)
Dog[c]	2 Years	2.5[f]	Inhibition of ALAD	(Azar *et al.* 1973)
Dog[c]	180 Days	3	Anorexia and convulsions	(Clark 1979)
European Starling[d]	Lifetime	4.1[g]	Reduced brain weight in nestlings, reduction in ALAD in red blood cells of adults and nestlings	(Grue *et al.* 1986)
Mallard[e]	42 Days	20[h]	Elevated lead levels in bone and eggs	(Haegele *et al.* 1974)

[a] Surrogate for long-eared owl
[b] Surrogate for mink
[c] Surrogate for fox
[d] Surrogate for robin and woodcock
[e] Surrogate for great blue heron
[f] Dose calculated from reported dose of 100 mg/kg based on average dog bodyweight of 10 kg and ingestion rate of 250 g/day
[g] Dose calculated from reported dose of 13.3 mg/kg (wet weight) based on average starling bodyweight of 75 g and ingestion rate of 23 g/day
[h] Dose calculated from reported dose of 100 mg/kg based on average mallard bodyweight of 1.25 g and ingestion rate of 0.25 kg/day

TABLE 8. Risk Estimates for Biota Utilizing the NL Industries site

SPECIES	LEAD IN MEDIA (mg/kg)	LOAEL (mg/kg/day)	DAILY INTAKE (SCENARIO 1) (mg/kg/day)	HAZARD QUOTIENT[1]	DAILY INTAKE (SCENARIO 2) (mg/kg/day)	HAZARD QUOTIENT
ROBIN	Soil, < 500	4.1	5.05	**1.23**	8.15	**1.99**
	Soil, 500-1000	4.1	9.46	**2.31**	12.17	**2.97**
	Soil, > 1000	4.1	20.51	**5.00**	34.49	**8.41**
WOODCOCK	Soil, < 500	4.1	41.76	**10.19**	68.40	**16.68**
	Soil, 500-1000	4.1	65.38	**15.95**	91.44	**22.30**
	Soil, > 1000	4.1	116.25	**28.36**	190.95	**46.57**
GREAT BLUE HERON AUF = 0.3%	Sediment, < 1000	20	0.02	0.00	0.03	0.00
	Sediment, 1000-2000	20	0.02	0.00	0.04	0.00
	Sediment, > 2000	20	0.12	0.01	0.12	0.01

Scenario 1: Dose calculated using mean lead concentration in animals
Scenario 2: Dose calculated using mean lead level plus 1 standard deviation
LOAEL: From Table 7
[1] The hazard quotient method compares calculated exposure concentrations to levels which have been shown to cause an ecological effect (Daily intake ÷ Reference dose = Hazard quotient). A hazard quotient greater than 1 indicates that exposure to contaminants at calculated levels may cause deleterious effects.

TABLE 8 (continued). Risk Estimates for Biota Utilizing the NL Industries site

SPECIES	LEAD IN MEDIA (mg/kg)	LOAEL (mg/kg/day)	DAILY INTAKE (SCENARIO 1) (mg/kg/day)	HAZARD QUOTIENT[1]	DAILY INTAKE (SCENARIO 2) (mg/kg/day)	HAZARD QUOTIENT
GREAT BLUE HERON AUF = 50%	Sediment, < 1000	20	3.84	0.19	5.01	0.25
	Sediment, 1000-2000	20	4.47	0.22	6.08	0.30
	Sediment, > 2000	20	19.04	0.95	19.99	**1.00**
RED-TAILED HAWK	Area II < 1000	3	0.20	0.07	0.40	0.13
	Area I & IA 1000-2000	3	0.11	0.04	0.18	0.06
	Area III > 2000	3	0.31	0.10	0.54	0.18
LONG-EARED OWL	Area II < 1000	3	0.53	0.18	1.05	0.35
	Area I & IA 1000-2000	3	0.27	0.09	0.46	0.15
	Area III > 2000	3	0.82	0.27	1.41	0.47

Scenario 1: Dose calculated using mean lead concentration in animals
Scenario 2: Dose calculated using mean lead level plus 1 standard deviation
LOAEL: From Table 7
[1] The hazard quotient method compares calculated exposure concentrations to levels which have been shown to cause an ecological effect (Daily intake ÷ Reference dose = Hazard quotient). A hazard quotient greater than 1 indicates that exposure to contaminants at calculated levels may cause deleterious effects.

TABLE 8 (continued). Risk Estimates for Biota Utilizing the NL Industries site

SPECIES	LEAD IN MEDIA (mg/kg)	LOAEL (mg/kg/day)	DAILY INTAKE (SCENARIO 1) (mg/kg/day)	HAZARD QUOTIENT[1]	DAILY INTAKE (SCENARIO 2) (mg/kg/day)	HAZARD QUOTIENT
RED FOX	Area II < 1000	2.5	1.19	0.48	2.25	0.90
	Area I & IA 1000-2000	2.5	1.94	0.78	3.00	**1.20**
	Area III > 2000	2.5	2.77	**1.11**	4.54	**1.82**
MINK, MALE	Area II < 1000	2	2.63	**1.32**	4.95	**2.48**
	Area I & IA 1000-2000	2	4.31	**2.17**	6.80	**3.40**
	Area III > 2000	2	6.55	**3.28**	10.57	**5.29**
MINK, FEMALE	Area II < 1000	2	2.94	**1.47**	5.47	**2.74**
	Area I & IA 1000-2000	2	4.82	**2.41**	7.59	**3.80**
	Area III > 2000	2	7.27	**3.64**	11.75	**5.88**

Scenario 1: Dose calculated using mean lead concentration in animals
Scenario 2: Dose calculated using mean lead level plus 1 standard deviation
LOAEL: From Table 7
[1] The hazard quotient method compares calculated exposure concentrations to levels which have been shown to cause an ecological effect (Daily intake ÷ Reference dose = Hazard quotient). A hazard quotient greater than 1 indicates that exposure to contaminants at calculated levels may cause deleterious effects.

APPENDIX A

Life History Information for Receptor Species

TABLE 1

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS FOR ROBIN (*Turdus migratorius*)

Body Weight:	78.4 g (Levey and Karasov 1989)
Dietary Ingestion Rate:	8.7 g/day (Levey and Karasov 1989)
Territory Size:	0.42 ha (Pitts 1984)
Soil Ingestion Rate:	0.8 g/day[a] (Beyer et al. 1991)
Diet:	43% Invertebrates (earthworms) 57% Vegetation

[a]Estimated soil ingestion rate (9.1% of dietary ingestion rate) using woodcock data, soil ingestion rates for robin are not available.

TABLE 2

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS FOR AMERICAN WOODCOCK (*Philohela minor*)

Body Weight:	165 g (Sheldon 1967)
Dietary Ingestion Rate:	83 g/day (Sheldon 1967)
Home Range:	44 ha (Wilson 1982) 38.2 to 171.2 ha (Hudgins 1985)
Soil Ingestion Rate:	7.5 g/day (Beyer et al. 1991)
Diet:	100% Earthworms

TABLE 3

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS FOR GREAT BLUE HERON (*Ardea herodias*)

Body Weight:	3.0 Kg (Newell et al. 1987)
Dietary Ingestion Rate:	0.6 Kg/day (Newell et al. 1987)
Territory Size:	30,000 ha[a] (Erwin and Spendelow 1991)
Soil Ingestion Rate:	54 g/day[b] (Beyer et al. 1991)
Water Ingestion Rate:	0.12 L/day (Calder and Braun 1983)
Diet:	85% Fish (Almost all aquatic)

[a]Estimated based upon a 10 km radius feeding area.

[b]Estimated soil ingestion rate (9% of dietary ingestion rate) using shore bird and Canada goose data, soil ingestion rate for great-blue heron are not available.

TABLE 4

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS FOR RED-TAILED HAWK (*Buteo jamaicensis*)

Body Weight:	1.3 kg (Kirkwood 1980)
Dietary Ingestion Rate:	136 g/day (Kirkwood 1980)
Home Range:	130 ha (Fitch et al. 1988)
Diet:	100% Small Mammals

TABLE 5

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS LONG-EARED OWL (*Asio otus*)

Body Weight:	222 g (Johnsgard 1987)
Dietary Ingestion Rate:	38 g/day (Johnson 1978)
Territory Size:	55 ha (Johnsgard 1987)
Diet:	100% Small Mammals

TABLE 6

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS FOR RED FOX (*Vulpes vulpes*)

Body Weight:	5 kg (Samuel and Nelson 1982)
Dietary Ingestion Rate:	320 g/day (Samuel and Nelson 1982)
Home Range:	57.5 to 162 ha (Samuel and Nelson 1982)
Soil Ingestion Rate:	9 g/day (Beyer et al. 1991)
Diet:	100% Small Mammals

TABLE 7

LIFE HISTORY INFORMATION USED IN DIETARY EXPOSURE CALCULATIONS FOR MINK (*Mustela vison*)

Body Weight:	1 kg (Bleavins et al. 1980)
Dietary Ingestion Rate:	150 g/day (Bleavins et al. 1980)
Home Range:	2630 m stream length, ♂ 1850 m stream length, ♀ (Linscombe et al. 1982)
Soil Ingestion Rate:	4.2 g/day[a] (Beyer et al. 1991)
Water Ingestion Rate:	0.10 L/day (Calder and Braun 1983)
Diet:	50% Small Mammals 50% Aquatic Biota (Frogs and/or Fish)

[a]Estimated soil ingestion rate (2.8% of dietary ingestion rate) using red fox data, soil ingestion rates for mink are not available.

APPENDIX B

Daily Intake Calculation Spreadsheets

RECEPTOR: ROBIN ROUTE OF EXPOSURE: SOIL
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN SOILS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SOILS (MG/KG/DAY)
AREA I AND IA					
MEAN	185	0.0008	12.76	100%	1.89
MEAN + SD	282	0.0008	12.76	100%	2.88
AREA II					
MEAN	553	0.0008	12.76	100%	5.64
MEAN + SD	594	0.0008	12.76	100%	6.06
AREA III					
MEAN	1609	0.0008	12.76	100%	16.42
MEAN + SD	2780	0.0008	12.76	100%	28.37

RECEPTOR: ROBIN ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: DIET = 100% EARTHWORMS

SCENARIO	LEAD IN EARTHWORMS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA						
MEAN	66.3	100%	0.0087	12.76	100%	7.36
MEAN + SD	110.5	100%	0.0087	12.76	100%	12.26
AREA II						
MEAN	80	100%	0.0087	12.76	100%	8.88
MEAN + SD	128.1	100%	0.0087	12.76	100%	14.22
AREA III						
MEAN	85.7	100%	0.0087	12.76	100%	9.51
MEAN + SD	128.4	100%	0.0087	12.76	100%	14.25

RECEPTOR: ROBIN ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: DIET = 100% EARTHWORMS

SCENARIO	LEAD IN SOILS (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA			
MEAN	1.89	7.36	9.25
MEAN + SD	2.88	12.26	15.14
AREA II			
MEAN	5.64	8.88	14.52
MEAN + SD	6.06	14.22	20.28
AREA III			
MEAN	16.42	9.51	25.93
MEAN + SD	28.37	14.25	42.62

RECEPTOR: ROBIN ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: DIET = 43% EARTHWORMS, 57% VEGETATION

SCENARIO	LEAD IN EARTHWORMS (MG/KG)	PERCENT OF DIET (%)	LEAD IN VEGETATION (MG/KG)	PERCENT OF DIET (%)	LEAD IN FORAGE (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA									
MEAN	66.3	43%	0	57%	28.51	0.0087	12.76	100	3.16
MEAN + SD	110.5	43%	0	57%	47.52	0.0087	12.76	100%	5.27
AREA II									
MEAN	80	43%	0	57%	34.40	0.0087	12.76	100%	3.82
MEAN + SD	128.1	43%	0	57%	55.08	0.0087	12.76	100%	6.11
AREA III									
MEAN	85.7	43%	0	57%	36.85	0.0087	12.76	100%	4.09
MEAN + SD	128.4	43%	0	57%	55.21	0.0087	12.76	100%	6.13

RECEPTOR: ROBIN ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: DIET = 43% EARTHWORMS, 57% VEGETATION

SCENARIO	LEAD IN SOILS (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA			
MEAN	1.89	3.16	5.05
MEAN + SD	2.88	5.27	8.15
AREA II			
MEAN	5.64	3.82	9.46
MEAN + SD	6.06	6.11	12.17
AREA III			
MEAN	16.42	4.09	20.51
MEAN + SD	28.37	6.13	34.49

RECEPTOR: WOODCOCK ROUTE OF EXPOSURE: SOIL
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN SOILS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SOILS (MG/KG/DAY)
AREA I AND IA					
MEAN	185	0.0075	6.06	100%	8.41
MEAN + SD	282	0.0075	6.06	100%	12.82
AREA II					
MEAN	553	0.0075	6.06	100%	25.14
MEAN + SD	594	0.0075	6.06	100%	27.00
AREA III					
MEAN	1609	0.0075	6.06	100%	73.14
MEAN + SD	2780	0.0075	6.06	100%	126.36

RECEPTOR: WOODCOCK ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN EARTHWORMS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA						
MEAN	66.3	100%	0.083	6.06	100%	33.35
MEAN + SD	110.5	100%	0.083	6.06	100%	55.58
AREA II						
MEAN	80	100%	0.083	6.06	100%	40.24
MEAN + SD	128.1	100%	0.083	6.06	100%	64.44
AREA III						
MEAN	85.7	100%	0.083	6.06	100%	43.11
MEAN + SD	128.4	100%	0.083	6.06	100%	64.59

RECEPTOR: WOODCOCK ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN SOILS (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA			
MEAN	8.41	33.35	41.76
MEAN + SD	12.82	55.58	68.40
AREA II			
MEAN	25.14	40.24	65.38
MEAN + SD	27.00	64.44	91.44
AREA III			
MEAN	73.14	43.11	116.25
MEAN + SD	126.36	64.59	190.95

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: SEDIMENTS
SCENARIO VARIABLE: AREA USE FACTOR = 0.3%

SCENARIO	LEAD IN SEDIMENTS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SEDIMENTS (MG/KG/DAY)
AREA I AND IA					
MEAN	371	0.054	0.33	0.3%	0.02
MEAN + SD	457	0.054	0.33	0.3%	0.02
AREA II					
MEAN	440	0.054	0.33	0.3%	0.02
MEAN + SD	563	0.054	0.33	0.3%	0.03
AREA III					
MEAN	1963	0.054	0.33	0.3%	0.11
MEAN + SD	1991	0.054	0.33	0.3%	0.11

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: SEDIMENTS
SCENARIO VARIABLE: AREA USE FACTOR = 50%

SCENARIO	LEAD IN SEDIMENTS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SEDIMENTS (MG/KG/DAY)
AREA I AND IA					
MEAN	371	0.054	0.33	50.0%	3.34
MEAN + SD	457	0.054	0.33	50.0%	4.11
AREA II					
MEAN	440	0.054	0.33	50.0%	3.96
MEAN + SD	563	0.054	0.33	50.0%	5.07
AREA III					
MEAN	1963	0.054	0.33	50.0%	17.67
MEAN + SD	1991	0.054	0.33	50.0%	17.92

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: WATER
SCENARIO VARIABLE: AREA USE FACTOR = 0.3%

SCENARIO	LEAD IN WATER (MG/KG)	INGESTION RATE (L/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE WATER (MG/KG/DAY)
AREA I AND IA					
MEAN	0.049	0.12	0.33	0.3%	0.00
MEAN + SD	0.082	0.12	0.33	0.3%	0.00
AREA II					
MEAN	0.257	0.12	0.33	0.3%	0.00
MEAN + SD	0.386	0.12	0.33	0.3%	0.00
AREA III					
MEAN	1.847	0.12	0.33	0.3%	0.00
MEAN + SD	2.543	0.12	0.33	0.3%	0.00

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: WATER
SCENARIO VARIABLE: AREA USE FACTOR = 50%

SCENARIO	LEAD IN WATER (MG/KG)	INGESTION RATE (L/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE WATER (MG/KG/DAY)
AREA I AND IA					
MEAN	0.049	0.12	0.33	50%	0.00
MEAN + SD	0.082	0.12	0.33	50%	0.00
AREA II					
MEAN	0.257	0.12	0.33	50%	0.01
MEAN + SD	0.386	0.12	0.33	50%	0.01
AREA III					
MEAN	1.847	0.12	0.33	50%	0.04
MEAN + SD	2.543	0.12	0.33	50%	0.05

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: AREA USE FACTOR = 0.3%

SCENARIO	LEAD IN FROGS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA					
MEAN	5.02	0.6	0.33	0.3%	0.00
MEAN + SD	8.98	0.6	0.33	0.3%	0.01
AREA II					
MEAN	5	0.6	0.33	0.3%	0.00
MEAN + SD	10.09	0.6	0.33	0.3%	0.01
AREA III					
MEAN	13.32	0.6	0.33	0.3%	0.01
MEAN + SD	20.22	0.6	0.33	0.3%	0.01

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: AREA USE FACTOR = 50%

SCENARIO	LEAD IN FROGS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA					
MEAN	5.02	0.6	0.33	50.0%	0.50
MEAN + SD	8.98	0.6	0.33	50.0%	0.90
AREA II					
MEAN	5	0.6	0.33	50.0%	0.50
MEAN + SD	10.09	0.6	0.33	50.0%	1.01
AREA III					
MEAN	13.32	0.6	0.33	50.0%	1.33
MEAN + SD	20.22	0.6	0.33	50.0%	2.02

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: AREA USE FACTOR = 0.3%

SCENARIO	LEAD IN SEDIMENTS (MG/KG/DAY)	LEAD IN WATER (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA				
MEAN	0.02	0.00	0.00	0.02
MEAN + SD	0.02	0.00	0.01	0.03
AREA II				
MEAN	0.02	0.00	0.00	0.03
MEAN + SD	0.03	0.00	0.01	0.04
AREA III				
MEAN	0.11	0.00	0.01	0.11
MEAN + SD	0.11	0.00	0.01	0.12

RECEPTOR: GREAT BLUE HERON ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: AREA USE FACTOR = 50%

SCENARIO	LEAD IN SEDIMENTS (MG/KG/DAY)	LEAD IN WATER (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA				
MEAN	3.34	0.00	0.50	3.84
MEAN + SD	4.11	0.00	0.90	5.01
AREA II				
MEAN	3.96	0.01	0.50	4.47
MEAN + SD	5.07	0.01	1.01	6.08
AREA III				
MEAN	17.67	0.04	1.33	19.04
MEAN + SD	17.92	0.05	2.02	19.99

RECEPTOR: RED-TAILED HAWK ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: AREA USE FACTOR = 21%

SCENARIO	LEAD IN MAMMALS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	TOTAL DOSE (MG/KG/DAY)
AREA I AND IA						
MEAN	1.6	100%	0.136	0.77	21%	0.04
MEAN + SD	2.67	100%	0.136	0.77	21%	0.06
AREA II						
MEAN	3.098	100%	0.136	0.77	21%	0.07
MEAN + SD	6.12	100%	0.136	0.77	21%	0.13
AREA III						
MEAN	4.77	100%	0.136	0.77	21%	0.10
MEAN + SD	8.26	100%	0.136	0.77	21%	0.18

RECEPTOR: RED-TAILED HAWK ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: AREA USE FACTOR = 63%

SCENARIO	LEAD IN MAMMALS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	TOTAL DOSE (MG/KG/DAY)
AREA I AND IA						
MEAN	1.6	100%	0.136	0.77	63%	0.11
MEAN + SD	2.67	100%	0.136	0.77	63%	0.18
AREA II						
MEAN	3.098	100%	0.136	0.77	63%	0.20
MEAN + SD	6.12	100%	0.136	0.77	63%	0.40
AREA III						
MEAN	4.77	100%	0.136	0.77	63%	0.31
MEAN + SD	8.26	100%	0.136	0.77	63%	0.54

RECEPTOR: LONG-EARED OWL ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: AREA USE FACTOR = 100%

SCENARIO	LEAD IN EARTHWORMS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA						
MEAN	1.6	100%	0.038	4.50	100%	0.27
MEAN + SD	2.67	100%	0.038	4.50	100%	0.46
AREA II						
MEAN	3.1	100%	0.038	4.50	100%	0.53
MEAN + SD	6.12	100%	0.038	4.50	100%	1.05
AREA III						
MEAN	4.77	100%	0.038	4.50	100%	0.82
MEAN + SD	8.26	100%	0.038	4.50	100%	1.41

RECEPTOR: LONG-EARED OWL ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: AREA USE FACTOR = 33.3%

SCENARIO	LEAD IN EARTHWORMS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA						
MEAN	1.6	33%	0.038	4.50	100%	0.09
MEAN + SD	2.67	33%	0.038	4.50	100%	0.15
AREA II						
MEAN	3.1	33%	0.038	4.50	100%	0.18
MEAN + SD	6.12	33%	0.038	4.50	100%	0.35
AREA III						
MEAN	4.77	33%	0.038	4.50	100%	0.27
MEAN + SD	8.26	33%	0.038	4.50	100%	0.47

RECEPTOR: RED FOX ROUTE OF EXPOSURE: SOIL
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN SOILS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SOILS (MG/KG/DAY)
AREA I AND IA					
MEAN	1022	0.009	0.2	100%	1.84
MEAN + SD	1570	0.009	0.2	100%	2.83
AREA II					
MEAN	550	0.009	0.2	100%	0.99
MEAN + SD	1030	0.009	0.2	100%	1.85
AREA III					
MEAN	1365	0.009	0.2	100%	2.46
MEAN + SD	2228	0.009	0.2	100%	4.01

RECEPTOR: RED FOX ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN MAMMALS (MG/KG)	PERCENT OF DIET (%)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA						
MEAN	1.6	100%	0.32	0.2	100%	0.10
MEAN + SD	2.67	100%	0.32	0.2	100%	0.17
AREA II						
MEAN	3.098	100%	0.32	0.2	100%	0.20
MEAN + SD	6.12	100%	0.32	0.2	100%	0.39
AREA III						
MEAN	4.77	100%	0.32	0.2	100%	0.31
MEAN + SD	8.26	100%	0.32	0.2	100%	0.53

RECEPTOR: RED FOX ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: NONE

SCENARIO	LEAD IN SOILS (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA			
MEAN	1.84	0.10	1.94
MEAN + SD	2.83	0.17	3.00
AREA II			
MEAN	0.99	0.20	1.19
MEAN + SD	1.85	0.39	2.25
AREA III			
MEAN	2.46	0.31	2.76
MEAN + SD	4.01	0.53	4.54

RECEPTOR: MINK ROUTE OF EXPOSURE: SOIL
SCENARIO VARIABLE: MALE

SCENARIO (MALE)	LEAD IN SOILS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SOILS (MG/KG/DAY)
AREA I AND IA					
MEAN	1022	0.0042	1	90%	3.86
MEAN + SD	1570	0.0042	1	90%	5.93
AREA II					
MEAN	550	0.0042	1	90%	2.08
MEAN + SD	1030	0.0042	1	90%	3.89
AREA III					
MEAN	1365	0.0042	1	90%	5.16
MEAN + SD	2228	0.0042	1	90%	8.42

RECEPTOR: MINK ROUTE OF EXPOSURE: SOIL
SCENARIO VARIABLE: FEMALE

SCENARIO (FEMALE)	LEAD IN SOILS (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE SOILS (MG/KG/DAY)
AREA I AND IA					
MEAN	1022	0.0042	1	100%	4.29
MEAN + SD	1570	0.0042	1	100%	6.59
AREA II					
MEAN	550	0.0042	1	100%	2.31
MEAN + SD	1030	0.0042	1	100%	4.33
AREA III					
MEAN	1365	0.0042	1	100%	5.73
MEAN + SD	2228	0.0042	1	100%	9.36

RECEPTOR: MINK ROUTE OF EXPOSURE: WATER
SCENARIO VARIABLE: MALE

SCENARIO (MALE)	LEAD IN WATER (MG/KG)	INGESTION RATE (L/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE WATER (MG/KG/DAY)
AREA I AND IA					
MEAN	0.049	0.1	1	90%	0.00
MEAN + SD	0.082	0.1	1	90%	0.01
AREA II					
MEAN	0.257	0.1	1	90%	0.02
MEAN + SD	0.386	0.1	1	90%	0.03
AREA III					
MEAN	1.847	0.1	1	90%	0.17
MEAN + SD	2.543	0.1	1	90%	0.23

RECEPTOR: MINK ROUTE OF EXPOSURE: WATER
SCENARIO VARIABLE: FEMALE

SCENARIO (FEMALE)	LEAD IN WATER (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWEIGHT (1 / KG)	AREA USE FACTOR (%)	DOSE WATER (MG/KG/DAY)
AREA I AND IA					
MEAN	0.049	0.1	1	100%	0.00
MEAN + SD	0.082	0.1	1	100%	0.01
AREA II					
MEAN	0.257	0.1	1	100%	0.03
MEAN + SD	0.386	0.1	1	100%	0.04
AREA III					
MEAN	1.847	0.1	1	100%	0.18
MEAN + SD	2.543	0.1	1	100%	0.25

RECEPTOR: MINK ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: MALE

SCENARIO (MALE)	LEAD IN MAMMALS (MG/KG)	PERCENT OF DIET (%)	LEAD IN FROGS (MG/KG)	PERCENT OF DIET (%)	TOTAL LEAD IN FORAGE (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA									
MEAN	1.6	0.5	5	0.5	3.30	0.15	1	90%	0.45
MEAN + SD	2.67	0.5	10.09	0.5	6.38	0.15	1	90%	0.86
AREA II									
MEAN	3.098	0.5	5.02	0.5	4.06	0.15	1	90%	0.55
MEAN + SD	6.12	0.5	8.98	0.5	7.55	0.15	1	90%	1.02
AREA III									
MEAN	4.77	0.5	13.32	0.5	9.05	0.15	1	90%	1.22
MEAN + SD	8.26	0.5	20.22	0.5	14.24	0.15	1	90%	1.92

RECEPTOR: MINK ROUTE OF EXPOSURE: FORAGE
SCENARIO VARIABLE: FEMALE

SCENARIO (FEMALE)	LEAD IN MAMMALS (MG/KG)	PERCENT OF DIET (%)	LEAD IN FROGS (MG/KG)	PERCENT OF DIET (%)	TOTAL LEAD IN FORAGE (MG/KG)	INGESTION RATE (KG/DAY)	1/BODYWGT (1/KG)	AREA USE FACTOR (%)	DOSE FORAGE (MG/KG/DAY)
AREA I AND IA									
MEAN	1.6	0.5	5	0.5	3.30	0.15	1	100%	0.50
MEAN + SD	2.67	0.5	10.09	0.5	6.38	0.15	1	100%	0.96
AREA II									
MEAN	3.098	0.5	5.02	0.5	4.06	0.15	1	100%	0.61
MEAN + SD	6.12	0.5	8.98	0.5	7.55	0.15	1	100%	1.13
AREA III									
MEAN	4.77	0.5	13.32	0.5	9.05	0.15	1	100%	1.36
MEAN + SD	8.26	0.5	20.22	0.5	14.24	0.15	1	100%	2.14

RECEPTOR: MINK ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: MALE

SCENARIO (MALE)	LEAD IN SOILS (MG/KG/DAY)	LEAD IN WATER (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA				
MEAN	3.86	0.00	0.45	4.31
MEAN + SD	5.93	0.01	0.86	6.80
AREA II				
MEAN	2.08	0.02	0.55	2.65
MEAN + SD	3.89	0.03	1.02	4.95
AREA III				
MEAN	5.16	0.17	1.22	6.55
MEAN + SD	8.42	0.23	1.92	10.57

RECEPTOR: MINK ROUTE OF EXPOSURE: TOTAL
SCENARIO VARIABLE: FEMALE

SCENARIO (FEMALE)	LEAD IN SOILS (MG/KG/DAY)	LEAD IN WATER (MG/KG/DAY)	LEAD IN FORAGE (MG/KG/DAY)	TOTAL LEAD INGESTED (MG/KG/DAY)
AREA I AND IA				
MEAN	4.29	0.00	0.50	4.79
MEAN + SD	6.59	0.01	0.96	7.56
AREA II				
MEAN	2.31	0.03	0.61	2.94
MEAN + SD	4.33	0.04	1.13	5.50
AREA III				
MEAN	5.73	0.18	1.36	7.27
MEAN + SD	9.36	0.25	2.14	11.75